

**REMARKS**

Claims 1-51 and 54 are pending in the application. All pending claims stand rejected and/or objected to for various reasons. The specification is objected to for lacking a proper "Abstract" section of the disclosure as required by 37 C.F.R. §1.72(b). Claims 9, 16, 20, 21, 24, 25, 33, 37, and 39 are objected to for certain informalities. Claims 1-31, 35-39, and 51 stand rejected under 35 U.S.C. §102(b) as being anticipated by Rao, Yun-Jiang, "In Fibre Grating Sensors", *Measurement Science and Technology* (hereinafter "Rao"), claim 32 stands rejected under 35 U.S.C. §103 as being unpatentable over Rao, and claims 50 and 54 stand rejected under 35 U.S.C. §103 as being unpatentable over Rao in view of WO 96/24079 (hereinafter "Ouellette").

Claims 1, 4, 6, 11-12, 15, 18-21, 23, 28, 33-34, 37, 39, and 44 are amended to respond to the Examiner's objections as discussed below. Claims 1 and 25 are amended to clarify that, at least in some embodiments, the refractive index varies periodically "during transmission" (as discussed in the application as filed at page 9). No new matter is believed added by any amendments presented herein. Support for all amendments exists in the specification and claims as originally filed, and all such matter has previously been searched by the Examiner. Applicants respectfully request reconsideration and further examination of the pending claims in view of the arguments presented herein and in accordance with 37 CFR §1.112.

**1. Objections to the Specification**

The specification is objected to for lacking an Abstract section of the disclosure as required by 37 C.F.R. §1.72(b). Applicants believe that an Abstract was provided as part of the PCT filing (and subsequently provided to the US Patent Office), however, to advance the case, a substitute Abstract is provided herewith. Applicants respectfully request that the objection to the specification be withdrawn.

**2. Objections to the Claims**

Claims 9, 16, 20, 21, 24, 25, 33, 37, and 39 are objected to for certain informalities. In particular, claims 9, 16, 20, 24, 25, and 33 are objected to for lacking antecedent basis, and claims 21, 37, and 39 are objected to for having awkward grammar and/or spelling errors. Claims

21, 37, and 39 are amended to correct all spelling and grammatical errors. Other claims have been amended to amend the alleged antecedent basis issues. However, Applicants respectfully note that "[i]nherent components of elements recited have antecedent basis in the recitation of the components themselves" (MPEP §2173.05(e)). That is, not all items recited in claims need to be preceded by an "a" or "an" as the Examiner appears to assert. Some items refer to inherent elements of components. For example, as recited in claims 9, 16 and 24, each grating has a "refractive index" and a "refractive index profile". Applicants respectfully assert that such components have antecedent basis in the recitation of the components themselves and that the claims as presented are definite and in compliance with 35 U.S.C. §112. To advance the case, claims 25 and 33 have been amended as requested by the Examiner.

Applicants respectfully submit that the scope of each of the claims (including the claims objected to) is "reasonably ascertainable by those skilled in the art," and is therefore not indefinite (MPEP §2173.05(e)). In light of the amendments and arguments presented herein, Applicants respectfully request that the objections to claims 9, 16, 20, 21, 24, 25, 33, 37, and 39 be withdrawn.

### ***3. 35 U.S.C. §102(b) Rejections - Rao***

Claims 1-31, 35-39, and 51 stand rejected under 35 U.S.C. §102(b) as anticipated by Rao. Applicants respectfully traverse this ground for rejection.

#### ***a. Independent Claims (1 and 25)***

Applicants respectfully assert that the Rao reference fails to teach, suggest, or make obvious elements of current embodiments as presented in claims 1 or 25 as amended. In particular, Applicants respectfully assert that the Rao reference fails to teach or suggest a fibre optic grating sensor as recited in claim 1 and having a grating portion along which the refractive index of the fibre varies periodically during transmission or in which the variation has an amplitude envelope with at least one region in which the amplitude is substantially reduced or in which the variation gives the grating portion a spectral profile within which there is at least one pass band.

Prior to a detailed discussion of the rejection of claim 1, a brief review may be helpful. Embodiments relate to fibre Bragg gratings, such as Bragg gratings that may be used as in-fibre

sensors. Unlike prior devices, which used arrays of Bragg gratings to make a quasi-distributed strain or temperature measurement across a short length, embodiments of the present invention provide a number of sensors within each grating portion. For example, as shown in the illustrative example of FIGs. 2 and 3, a moiré grating (or "grating portion") may be fabricated pursuant to embodiments of the present invention, which allows 10 measurements to be taken along the length of a single grating portion. That is, each of the measurements may be taken at "sensor" locations within a grating portion that are regions within the fibre core where nulls in an amplitude envelope are formed. The exact position of each of these sensors may be calculated using the spectral profile of the grating portion, knowing the length of the grating portion and the manner in which the grating is chirped (in embodiments using chirped gratings). Using previous techniques, the implementation of 10 sensors would have required the use of an array of gratings. An array of 10 linear gratings would have a spectral bandwidth of more than 50nm (while embodiments of the present invention would reduce the required operating spectral bandwidth by more than 40nm).

The Rao reference fails to teach or suggest such a device. In particular, Applicants respectfully assert that the Rao reference fails to teach or suggest a fibre optic grating sensor having a grating portion along which the refractive index of the fibre varies periodically during transmission. Applicants respectfully suggest that the Examiner has misconstrued the Rao reference. No such grating portion is discussed, taught or suggested in the Rao reference. The Examiner refers to Rao at page 356, paragraph 2.1. Applicants have read this section and find no suggestion of such a claimed grating portion, nor any suggestion of any modulation along the grating portion. Instead, it appears that the Examiner may be referring to the passband mentioned by Rao (which, as discussed in conjunction with Rao's Figure 2, is a single passband determined by the entire grating length). Applicants respectfully point out that the referenced passband of Rao is a passband measured in reflection. Applicants device, if measured in reflection, would have an additional stopband in the reflection passband for each position along the moiré sensor where the amplitude of the refractive index modulation reduces. To clarify the distinction between reflection and transmission, Applicants have amended claim 1 to recite that the refractive index of the fibre varies periodically during transmission. No such feature is taught or suggested by Rao. Applicants respectfully assert that if the passband mentioned by Rao were measured in transmission that it would manifest itself as a single stopband. A grating

having a single stopband is not a grating portion along which the refractive index of the fibre varies periodically during transmission. At least for this reason, Applicants respectfully assert that the Rao reference does not teach or suggest embodiments of the present invention as recited in amended claim 1.

Further, Applicants respectfully assert that the Rao reference does not teach the claimed amplitude envelope that includes at least one region in which the amplitude of the envelope is substantially reduced. As discussed above, embodiments provide a grating portion in which a number of nulls (or areas where the grating strength is reduced or nulled) are provided. As claimed, the region of the amplitude envelope is associated with the grating portion. The Examiner refers to Figure 2 of Rao as showing such a feature. Applicants respectfully assert that the Examiner has misconstrued the teachings of Rao. Figure 2 of Rao shows a schematic of a chirped grating where the black marks along the fibre length show the spatial separation of grating fringes of a grating. There is simply no teaching or discussion of a region in which the amplitude of the envelope is substantially reduced (where the envelope is associated with a periodic variation of the refractive index along a grating portion). The grating fringes represented by the figures of Rao are not grating regions. A grating region may consist of a number of grating fringes. Further, even if the grating fringes were "regions" as claimed, there still is no teaching or suggestion of at least one region in which the amplitude of the envelope is substantially reduced.

Applicants respectfully suggest that claim 1, as amended, is patentable over the Rao reference at least for these reasons. Further, there is simply no teaching or suggestion in Rao to modify Rao to provide the missing features. Applicants respectfully assert that the Rao reference, at most, generally describes the same Bragg gratings as are discussed in the background portion of the present application. To provide multiple sensor locations Rao, like other prior art devices, would require an array of gratings. Embodiments allow multiple sensor locations to be implemented within a single grating portion.

Claim 25 is believed patentable for similar reasons. As discussed above, the Rao reference fails to teach or suggest a grating portion along which the refractive index of the fibre varies periodically in transmission. Further, the Rao reference fails to teach or suggest a sensor having a grating portion in which the phase of the periodic variation substantially reverses. The Examiner refers to Rao at sections 4.1 through 4.3. Applicants respectfully point out that the

cited sections deal with "interrogation techniques" and the phase changes discussed in those sections refer to phase changes of the interrogation signals. Claim 25 recites that the phase changes are in conjunction with the operation of the sensor itself. A phase change of an interrogation signal is not the same as a phase change in sensor operation. As such, claim 25 is patentable over the cited reference. Further, there is simply no teaching or suggestion in Rao to provide such a feature.

***b. Dependent claims***

Each of the dependent claims (claims 2-24 and 26-52) are believed patentable at least as depending from a patentable base claim. Each of the dependent claims are generally directed to subject matter not taught or described by Rao. For example, as recited in claims 2 or 3, there is simply no teaching in Rao of an amplitude envelope having a plurality of regions (where the amplitude is substantially reduced or substantially nulled). Again, Rao describes a single passband which, if measured in transmission, would manifest itself as a single stopband. No envelope having a plurality of regions is taught or suggested by Rao, and claims 2 and 3 are believed additionally patentable for these reasons.

As another example, claims 4-7 and 29 recite further features of the claimed regions and are further patentable over the Rao reference because Rao does not teach or suggest the use of such a plurality of regions. Further, regarding claims 7 and 29, each of the phase shift sections along the grating length (each corresponding to a different passband in the main grating stopband) can be interrogated independently of each other. This effectively provides a plurality of independent sensor elements even within a single grating portion. The Rao reference simply fails to teach or suggest such a device. At most, Rao describes a grating which may operate as a single sensor (not as a plurality of independent sensors). Claims 7 and 29 are believed patentable for this additional reason.

As another example, claim 8 recites the use of two substantially superimposed fibre Bragg gratings as the grating portion. The claimed grating portion requires that the refractive index vary periodically across the grating portion. As discussed in the specification, this requires that the two superimposed gratings be formed with wavelengths that are very close to each other (to form a "beat pattern"). The two superimposed gratings referenced in Rao are formed to have wavelengths that are far apart from each other (described by Rao as 0.85 $\mu$ m and 1.3  $\mu$ m). That

is, the two superimposed gratings of Rao could not be used to implement the embodiment of claim 8 (unless the teaching of Rao were ignored).

As a further example, claim 9 is additionally believed patentable because Rao does not teach or describe the use of two superimposed gratings in which the amplitudes of the refractive index profiles of the two gratings form the amplitude envelope. The section of Rao referred to by the Examiner describes the deformation of the shape of the periodic modulation that forms the grating. This effect is uniform along the grating length and does not result in an amplitude variation of the index modulation along the grating length. Although harmonics may result, they are not the claimed amplitude envelope (and apparently will be formed at twice the main grating wavelength).

As other examples, claims 10-12 relate to embodiments which utilize chirped fibre Bragg gratings. While the Rao reference describes some basic chirped gratings, as discussed above, there is simply no teaching or discussion in Rao to utilize them (or any other form of grating structure) as recited in the instant claims.

Claims 11, 12, 14, 15, 31, 32, 33, and 34 generally recite features of embodiments that provide compound grating structures configured to have similar properties (e.g., similar wavelengths allowing creation of the claimed amplitude envelope). While the Rao reference does describe the use of two fibre gratings simultaneously, it does so either to distinguish between strain and temperature effects or to compensate for the effect of temperature on a strain sensing grating by using a reference grating. Such unrelated gratings are simply unable to generate the recited amplitude envelope and are unable to operate together to provide the claimed features of the present invention. Other dependent claims not discussed herein are believed patentable at least as depending from patentable base claims.

#### ***4. 35 U.S.C. §103 Rejections - Rao***

The Examiner has rejected claim 32 as obvious over Rao. As discussed above, Rao only refers to the use of two gratings in situations where two different gratings are used to distinguish between strain and temperature effects, or use of a second grating as a reference grating. There is simply no teaching or suggestion in Rao to provide two gratings which together may form an amplitude envelope as recited in the independent claims. Further, as recited in claim 32, there is no teaching or suggestion in Rao to provide such a claimed spatial shifting (instead, as discussed

by Rao, where two gratings are formed in proximity, they have substantially different wavelengths). Further, there is simply no teaching or suggestion in the Rao reference to provide such a feature. Applicants respectfully request that the Examiner remove the §103 rejection.

**5. 35 U.S.C. §103 Rejections - Rao in view of Ouellette**

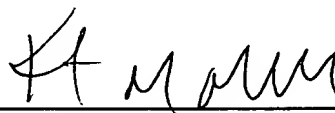
The Examiner has rejected claims 50 and 54 as obvious over Rao in view of Ouellette. Applicants respectfully assert that claims 50 and 54 are patentable at least as depending from patentable base claims.

**6. Conclusion**

Accordingly, Applicants respectfully assert that each of the claims are patentable over the cited references. Applicants therefore respectfully request that the Examiner's rejection of the pending claims be withdrawn. Applicants' silence with respect to other comments made in the Office Action does not imply agreement with those comments. Applicants hereby request a 1-month extension of time. The fee pursuant to 37 CFR 1.17(a)(4) is included herein. If any issues remain, or if the Examiner has any further suggestions for expediting allowance of the present application, the Examiner is kindly invited to contact the undersigned via telephone at 203-972-0081.

Respectfully submitted,

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Date



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